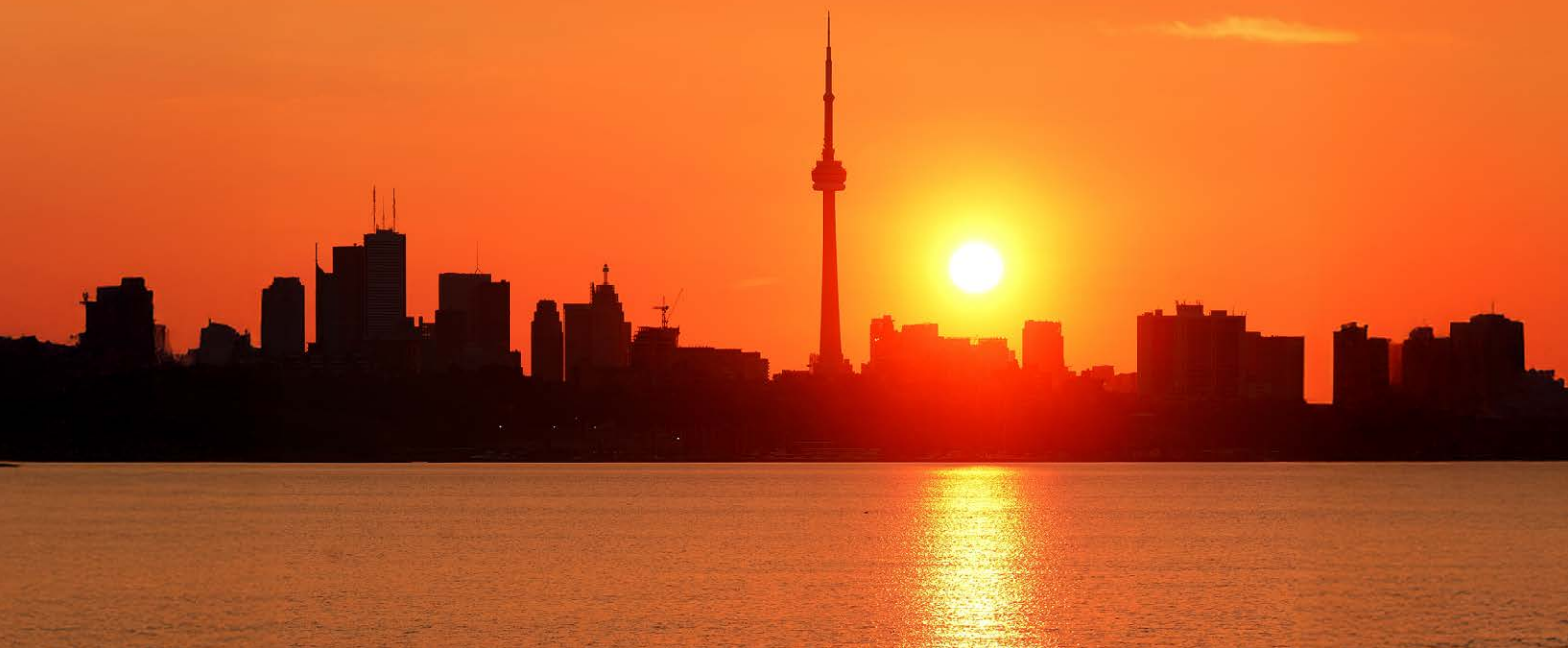
Needs Assessment Report ECCC

Enhancing British Columbia's Heatwave Forecasting System



Solutions Scholar:
Emily Kaakyo Rubooga
Interdisciplinary Studies (Community Engagement, Social Change and Equity)
Irving K. Barber Faculty of Arts and Social Sciences

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Executive Summary

This needs assessment report presents key findings and strategic insights from a consultative research initiative conducted as part of the Enhancing Heatwave Forecasting and Public Uptake collaboration between the University of British Columbia (UBC) and Environment and Climate Change Canada (ECCC). The goal of this assessment was to understand how to increase the effectiveness and public uptake of heatwave warnings in British Columbia (BC), particularly in light of growing climate-related health risks

.

Through interviews and focus group discussions with key ECCC stakeholders—particularly operational forecasting and climate risk management teams—this report captures gaps, opportunities, and priorities in current heatwave warning systems. The insights reflect both technical and behavioral dimensions, emphasizing the need for more personalized, accessible, and actionable forecast information.

Purpose of the Report

- Provide a baseline understanding of current challenges and needs in BC's heatwave forecasting system.
- Support internal reflection and alignment across ECCC and UBC teams.
- Offer a reference for future investments, applied research, student engagement, and intervention design.
- Inform the development of user-centered, AI-supported forecasting tools.

This report is designed primarily as an internal working document for UBC and ECCC collaborators. It is intended to:

- Inform future rounds of research and stakeholder engagement.
- Guide students, designers, and practitioners in identifying meaningful entry points for innovation.
- Serve as a reference for evaluating current and future initiatives in heatwave risk communication and preparedness.

We hope this synthesis supports thoughtful, strategic, and collaborative action in making BC's heatwave forecasting system more responsive, inclusive, and impactful.

Acknowledgements

This report would not have been possible without the generous contributions of our interviewees and focus group participants from Environment and Climate Change Canada (ECCC).

We are especially grateful to the following individuals, who shared their time, expertise, and experiences—contributions that deeply informed the insights presented in this document:

- **Melissa MacDonald** – HAQ Program Meteorologist, ECCC
- **Armel Castellan** – Warning Preparedness Meteorologist, ECCC
- **Brittany Murphy** – Health and Air Quality Program Officer/Coordinator, ECCC
- **Lisa Vitols** – Senior Engagement and Strategy Advisor, ECCC
- **Céline Audette** – Lead, Air Quality Health Index, ECCC

Your leadership and dedication to advancing climate communication and public safety in British Columbia are sincerely appreciated. We hope this report reflects the value of your insights and supports your continued efforts.



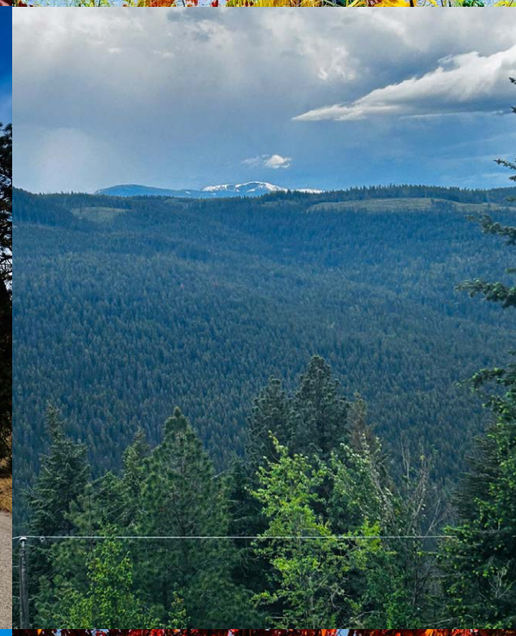



Table of Contents

Introduction

This report presents the key findings from a needs assessment aimed at improving British Columbia's (BC) heatwave forecasting system. Through consultations with key stakeholders from two primary units within the ECCC, the assessment focused on:

- Identifying gaps and challenges in the current heatwave forecasting and uptake.
- Exploring opportunities for targeted improvements to enhance accessibility and actionability.
- Learning from global best practices to integrate successful innovations into BC's system.

This needs assessment serves as a baseline—situational analysis, providing actionable insights to support decision-making, research investments, and potential collaborations in designing user-centric forecasting solutions. The report is structured around these three key objectives.

Background to the Needs Assessment

In response to the increasing impact of extreme heat events, this needs assessment was conducted to evaluate BC's heatwave forecasting system. The objective was to pinpoint gaps in the current early warning systems, explore opportunities for improvement, and integrate best practices from global innovations to enhance both forecasting accuracy and public engagement strategies.

The assessment was carried out as part of the Enhancing Heatwave Forecasting and Public Uptake – UBC-ECCC Collaborative Research Project, a cross-departmental initiative in partnership with Environment and Climate Change Canada (ECCC). The project investigates how machine learning can be leveraged to extend lead times for heatwave predictions and improve public understanding and response.

About the UBC-ECCC Collaborative Research Project

This research collaboration brings together expertise from both UBC and ECCC:
ECCC researchers:

- Dominique Brunet – Research Physical Scientist, ECCC
- Daniel Michelson – Research Manager, ECCC
- Dr. Dave Hudak – Scientist Emeritus, ECCC

UBC faculty mentors:

- Dr. Rachel White, an atmospheric scientist specializing in extreme weather events, including her work on the 2021 Pacific Northwest heatwave.
- Dr. Farrukh Chishtie, an occupational science researcher focused on applying machine learning models to predict extreme events.

UBC faculty mentors:

- Dr. Rachel White, an atmospheric scientist specializing in extreme weather events, including her work on the 2021 Pacific Northwest heatwave.
- Dr. Farrukh Chishtie, an occupational science researcher focused on applying machine learning models to predict extreme events.

Graduate student team:

- Jing Jiang PhD – Forest and Conservation Sciences
- Vicky Lucas MSc – Institute for Resources, Environment and Sustainability
- Emily Kaakyo Rubooga MA – Interdisciplinary Graduate Studies

Together, the team explored how their research could support ECCC's operational forecasting and enhance its usability for end users.

Stakeholder Engagement & Needs Assessment Approach

To understand user needs and challenges, the study employed a consultative process with key stakeholders—operational and service teams—from two primary sections responsible for forecasting and climate risk management. These discussions aimed to capture user experiences, focusing on how stakeholders interact with, perceive, and respond to early warning systems—particularly those incorporating AI-driven models.

The consultative process centered on three key questions:

- How do different stakeholders engage with existing heatwave forecasting tools?
- What are the challenges in accessibility, public uptake, and decision-making?
- How can improved forecasting models better support both operational teams and public response?

The insights gathered will directly inform the design phase of the project, ensuring that technological innovations align with real-world needs and drive meaningful improvements in public adoption.

Additionally, we prioritized user-friendly outputs and decision support systems, ensuring that forecasting tools are not only technically robust but also intuitive for end users. The discussions also examined broader social, behavioral, and structural factors influencing model adoption, preparedness, and response.

To make these insights actionable, we asked stakeholders directly:

- What works? What doesn't?
- What would an ideal forecasting and alert system look like?
- How can we make models more actionable and useful in decision-making?

Their feedback shed light on critical challenges, including accessibility, public uptake, decision support, and the need for better coordination and technological integration.

User Experience (UX) Design & Visioning Exercise

To bridge the gap between insights and implementation, we conducted a visioning exercise with participants, asking:

"If you could design the ideal forecasting system, what would it look like?"

This exercise helped identify key UX design elements, ensuring that any innovations—whether a machine learning model or an improved public engagement strategy—are designed with usability in mind.

The findings from this needs assessment will directly inform the development of solutions that prioritize user needs, whether through:

- Refining machine learning models
- Enhancing public messaging strategies
- Improving decision-support tools for forecasting teams

This report synthesizes and consolidates key insights, providing an overview of the current landscape, key challenges, priorities, and actionable pathways for enhancing BC's heatwave forecasting system. Direct quotations from participants illustrate important points, preserving the integrity of their responses and ensuring their voices remain central to the findings. We hope this report serves as a valuable internal resource for academic research and agency decision-making, guiding strategic investments in forecasting improvements.

Key Insights from Needs Assessment

1. User-Friendly Outputs

- Need for more personalized and tailored warnings/alerts for specific populations and risk groups

"It would be really cool if there was some sort of interface where a user could put in their profile that highlights what their vulnerabilities are, their sensitivities, and then it would take what warnings or alerts or conditions are there and then give them personalized information about how to act on them."

"We are trying to put as much information as possible so that as many people get what's relevant to them in the warning as possible. But then we're constantly in this battle of having warnings that are too long and then people sort of just tune them out."

- Desire for automated generation of regional forecasts from point-based data

"And I think being able to just click on the map and get a little pop-up model forecast for your point instead of these forecasters doing it would be really helpful."

- Interest in using AI to simplify technical language to more accessible reading levels

"Having the decision support system produce information at different reading levels—like grade 5—would improve accessibility and understanding."

- Potential for gamification and other interactive features to increase public engagement with weather information

"If we could turn preparedness into a game, where people get reminders and incentives for following heat safety advice, we might see better uptake."

2. Decision Support

- Opportunity to automate certain processes to free up forecasters for more impactful work

"There is a reluctance on the behalf of forecasters to take their hands off of that, but automating the process would let them focus more on impact-based messaging and partner engagement."

- Need for better integration of real-time impact data (e.g., hospital admissions) to inform warnings

"We really do depend on that real-time or as close to real-time data about what the impacts are, but getting that data across different jurisdictions is challenging."

"A syndromic surveillance system that's tied into the forecasting process could help forecasters better understand the on-the-ground impacts and tailor their warnings accordingly. Automating the data integration and analysis could free up forecasters."

• Desire for a system allowing partners to set custom notification criteria and thresholds

"What I would love to see is a system where whoever's in charge of the program, the partner in charge, goes in, sets the criteria thresholds they need exactly as they want—multiple days, max/min values, maybe humidex—and then lists the people who should receive push notifications."

3. Cross-Agency Collaboration

• Challenges with interprovincial differences in health systems and emergency management

"There are definitely some provinces that are hard to get to the table. They haven't had enough heat to consider it to be a concern, and that makes it difficult to implement consistent strategies nationwide."

• Need for better coordination between public health, emergency management, and weather services

"I think the tie-in between emergency management and public health needs to be strengthened. Right now, there's still a disconnect between the two in how we approach heat risks."

• Opportunity to integrate data from multiple sources (e.g., citizen science, road sensors) into forecasts

"We should be leveraging citizen science data—things like personal weather stations, heat mapping projects, even data from road temperature sensors—to refine our forecasts."

4. Behavioral Aspects

• Difficulty in communicating risk levels and getting appropriate public response

"It's not just about getting an alert. It's about knowing what to do with that information in the moment."

• Need to address "weather amnesia " and maintain public awareness between extreme events

"People have so much weather amnesia. It's suddenly here today, and I completely forget that two days ago it was torrentially raining."

• Opportunity to leverage behavioral science research to improve warning messaging

"We need to experiment with how we phrase warnings. Does a color-coded system work better? Does using personal stories drive more action? We should be testing these things."

5. Feedback Mechanisms

• Limited current feedback channels (app ratings, email inquiries)

"Right now, the only way we get public feedback is through app ratings or if someone takes the effort to send an email. That's not enough."

• Interest in more iterative, real-time feedback collection

"I should be able to tell the system when an alert was helpful or when it wasn't. That way, the messaging can evolve over time."

• Potential to use citizen science and social media engagement as informal feedback

"If we could integrate feedback into social media—like quick reaction polls after a heatwave event—we'd have a much better sense of what worked and what didn't."

6. Emerging Challenges

• Communicating uncertainty and confidence levels in longer-range forecasts

"How do we communicate the likelihood of an event happening without over-alerting people? If we say 'possible,' they don't take it seriously. If we say 'probable,' we risk crying wolf."

• Addressing public trust issues and competing information sources

"The Maritimes was that their go-to information for the warnings and the weather was the television and a little bit the radio. ECCC sources were way down the list—like number 11, like 8% of how they got their information."

"And even though the authoritative source is saying this is going to be a big, deadly, deadly, deadly, deadly storm, like the likes of which you've never seen, they're like, no, I'm going to stay home. I've seen storms before. I mean, sometimes you just can't get past that."

• Adapting to shifting baselines as climate change progresses

"What used to be an extreme event is becoming more common, so how do we adjust our alerting system to reflect that? If we keep using the same thresholds, we might start under-alerting when we need to. "

7. Opportunities for Impact

• Leveraging AI advances to improve forecast accuracy and lead times

"We have all this AI capability—why aren't we using it more to automate regional forecasts and improve lead times?"

"If you get the citizen science in, that's an actual observation from my house. Then when you do a point forecast when I click on my house and it's pulling from that and not just the model, wouldn't that be better?"

• Leveraging AI/ML to automate and personalize forecast outputs

- Use AI/ML to generate more tailored, impact-focused forecast information for specific regions or demographics, freeing up forecasters to focus on higher-level analysis and warnings.
- Explore automating the process of translating technical meteorological data into plain language, more accessible forecast summaries.

• Developing more targeted, impact-based warning systems
- Integrate behavioral insights and user feedback to design multi-tiered, impact-based warning systems that better motivate protective actions.
- Explore ways to quickly pilot and iterate on warning messaging to optimize for effectiveness.

"Heat warnings shouldn't just tell me that it's hot. They should tell me what's going to happen to people like me in these conditions."

• Improving public education and risk communication to drive protective behaviors
- Leverage interactive, gamified approaches to engage the public and improve understanding of weather risks and preparedness.
- Explore ways to better integrate citizen science and crowdsourced observations to enhance the relevance and usefulness of weather information.
- Strengthen partnerships with media outlets to amplify authoritative weather messaging.

"People don't understand what a heat warning actually means. We need to do more public education around what they should be doing when they see one."

"We need to make sure we are building partnerships with them [media partners] and getting our messaging out through all these leveraged ways because we're not the top reason people are finding out about things."

8. Key Priorities

• Implementing syndromic surveillance systems for real-time health impact data

"If we could pull in real-time hospital admission data, we'd be able to see the impact heat is having and adjust warnings accordingly."

• Increasing resources for on-the-ground response and most at-risk population support

"If they were more resourced, we probably would see no heat-related mortality if everything was in place properly."

• Improving partnerships with media and other information dissemination channels

"Leveraging some of those applications to get that information out... We have the forecasts, we have the technology, but let's get it into people's homes and workplaces where they'll actually see it."

The quotes by stakeholders reinforce the urgency of improving forecast accessibility, public engagement, real-time adaptability, and multi-agency collaboration. The key takeaway is that a more human-centered, technologically driven, and behaviorally-informed approach is needed to increase public responsiveness and improve the overall effectiveness of heat warnings.

Part 1:

Stakeholder Needs Assessment

1. Identified Gaps in British Columbia's Heatwave Forecasting System

1.1 Limited User Accessibility

One of the most pressing challenges identified is the limited accessibility of weather forecasts and heat warnings. Participants pointed out that while Environment and Climate Change Canada (ECCC) provides forecasts, many people receive weather information from other sources—especially media outlets and private weather networks. Language barriers also play a role, as the requirement is to provide bilingual (English and French) forecasts.

"The Maritimes was that their go-to information for the warnings and the weather was the television and a little bit the radio. ECCC sources were way down the list—like number 11, like 8% of how they got their information."

Additionally, the forecasting system lacks personalization, making it difficult to provide targeted alerts based on individual vulnerabilities. Heat warnings are issued for broad geographic areas, which may not align with individual risk thresholds.

"And there might be, we know that there might be at the various jurisdictional levels, they might have thresholds that they use that don't match our heat warning threshold, but if we were to use those thresholds for our heat warnings, we would be over-alerting the general public."

Participants suggested that a more user-defined system could improve accessibility, allowing individuals to input personal sensitivities—such as pre-existing health conditions or workplace exposure levels—and receive tailored warnings based on those factors.

"It would be really cool if there was some sort of interface where a user could put in their profile that highlights what their vulnerabilities are, their sensitivities, and then it would take the warnings or alerts and give them personalized information about how to act on them."

The current temperature notifications in the ECCC WeatherCAN app are designed for the general public, with preset thresholds based on air quality and temperature. However, partner agencies cannot customize these criteria or configure notifications based on multi-day thresholds.

Moreover, while mobile apps provide weather notifications, many users are unaware of these features or do not actively engage with them. This underscores the need for more intuitive and widely promoted forecasting tools that encourage public participation and proactive risk mitigation.

"That still, to a certain extent, requires the person to be aware of and know to set that up... Do they necessarily know that?"

"Our system puts the onus on individuals to download an app and create their own alerts, but many don't do it."

1.2 Inconsistent Public Uptake of Weather Information

Optimism Bias and Underreaction:

A recurring theme was that, despite improvements in forecasting accuracy, public response to heat warnings remains inconsistent. Participants emphasized that extreme heat is often underestimated, with many perceiving it as merely 'a nice day' rather than life-threatening. As a result, protective action is frequently neglected, even when warnings are issued well in advance—a classic case of optimism bias. This cognitive shortcut leads people to believe they will be unaffected by extreme heat, especially if they are healthy or have access to cooling options. As one participant put it:

"People consider Canada a cold country and for the general population, even when we're talking about extreme heat, seeing that as, 'Oh my goodness, it's just a really nice day.'"

"The cognitive dissonance between 'this may not affect you as a healthy adult with shade and a house with AC and the ability to take time off in the afternoon and jump in the water because you live close enough to it; compared to people without these privileges' makes it hard to communicate risk."

Weather Amnesia as Recency Bias:

Furthermore, participants observed that people tend to forget the intensity or danger of past extreme weather events, leading to what was described as "weather amnesia.

"This can be linked to recency bias, where individuals disproportionately prioritize current or recent conditions while underestimating prior events.

"People have so much weather amnesia. It's suddenly here today, and I completely forgot that two days ago it was torrentially raining."

Even when early warnings are provided, many decision-makers and organizations wait until the last moment to act.

"Many of our decision-making partners will not make decisions or begin to act until the day before, despite receiving four days of lead time for heat warnings."

To address these issues, stakeholders suggested leveraging behavioral science insights, including gamification, citizen science initiatives, and stronger partnerships with trusted media sources, to enhance public and institutional responsiveness to heat warnings.

1.3 Decision Support Systems

Participants from both teams recognized the importance of shifting from manual forecasting to a more automated, impact-based system. Participants noted the potential of using hybrid approaches that combine numerical weather prediction with machine learning to extend forecast lead times. If these techniques can reliably improve lead time and confidence, it could allow forecasters to focus more on communicating the impacts rather than just the basic forecast.

However, they also noted that many forecasters remain reluctant to rely on AI-driven forecasting, but stakeholders believe automation could enhance decision-making and free up forecasters to focus on impact-based messaging.

"There is a reluctance on the behalf of forecasters to take their hands off of that."

They also expressed a desire to create partner-driven notification systems, where partner agencies (e.g. public health, emergency management) set their own thresholds. This would allow the agencies to receive targeted alerts tailored to their specific needs, rather than having to parse through general public warnings. Automating this personalized notification process could save forecasters time:

"I would love to see a system where whoever's in charge of the program goes in, sets the criteria thresholds they need, exactly as they want, and then the system automatically notifies the right people."

Additionally, participants stressed the need for forecast outputs tailored to varying literacy levels to improve comprehension.

"Having the decision support system produce information at different reading levels—like grade 5—would improve accessibility and understanding."

Participants also stressed the need for integrated feedback mechanisms, allowing the public to provide input on forecasts and warnings in real-time. This would enable a more iterative approach to weather communication, ensuring that future messages are better aligned with public needs and expectations.

1.4 Personalized and Real-Time Forecasting

There was broad consensus that forecasting systems need greater real-time adaptability, with forecasts and notifications tailored not only by location but also by individual vulnerability factors. This would enable a more effective response to evolving heat conditions.

Syndromic Surveillance Integration: Participants proposed an ideal system that incorporates syndromic surveillance, using real-time health data to inform warnings. For example, if emergency departments or hospitals report an increase in heat-related illnesses, this data could trigger more urgent alerts or adjust messaging strategies accordingly.

"One thing that we've been really trying to stress with our health partners when we talk to them is something called a syndromic surveillance system where it's looking at what are the hospital admissions, what are the rates of fatalities? But the biggest challenge with that is how each jurisdiction will code some of that information. They code it differently from jurisdiction to jurisdiction because you're dealing with health data, obviously there's concerns around privacy and wanting to safeguard that data."

Another opportunity is citizen science integration, leveraging personal weather stations and community observations to refine forecasting models.

"If we could integrate user-generated temperature data from personal weather stations, we'd get much better localized forecasting."

Finally, stakeholders also noted the potential of integrating heat warnings into widely used health and wellness apps such as Samsung Health or Telus Health to increase uptake.

"If you put in that you have asthma or a health condition, we could integrate heat alerts into those applications to tell you, 'This isn't a good time to go running."

2: Key Priorities for User-Friendly Forecasting & Decision Support

2.1 Enhanced Accessibility and Inclusivity

To improve accessibility, participants stressed the importance of multilingual and multimodal communication. Weather warnings should be available in multiple languages and formats, including audio alerts, visual infographics, and interactive voice response systems to reach diverse populations.

Additionally, there is a need to simplify risk communication. Current warnings often contain technical terms that are not easily understood by the public. Stakeholders suggested that behavioral science experiments—such as color-coded warning levels or tiered messaging approaches—could make heat alerts more intuitive and actionable.

Multilingual and Multimodal Communication

- ECCC provides information in both official languages
- Need for a multi-channel strategy to reach diverse audiences, including media partnerships and AI-driven summaries.

Simplified Risk Communication

- Shift toward plain-language messaging using AI-generated, impact-based forecasts.
- Challenges in balancing technical accuracy with clear public communication.
- Behavioral science experiments (e.g., color-coded warnings) are being explored.

2.2 Real-Time Adaptability in Heatwave Forecasting

2.2.1 Dynamic, Interactive Dashboards

Participants highlighted the need for user-centric weather dashboards that integrate diverse data sources, incorporate real-time feedback, and provide tailored, impact-based information. Such dashboards would support preparedness and decision-making by allowing agencies to rapidly adjust warnings as conditions change. Features could include hyper-localized forecasts and geolocation-based alerts, ensuring individuals receive notifications relevant to their exact location.

• ***Customizable Decision-Support Systems***
For emergency management agencies, a customizable decision-support system could enhance coordination by allowing users to set their own alert thresholds and receive notifications when those thresholds are exceeded. This flexibility would help agencies respond more effectively to evolving heat risks.

• ***Automated and Flexible Forecast Outputs***
Participants expressed interest in more automated, point-based forecasting, envisioning a system where users could "just click on the map and get a little pop-up model forecast for your point instead of these forecasters doing it." AI-generated, location-specific forecasts could improve accessibility and ease of use, making weather data more actionable for both agencies and the public.

• ***Integrating Citizen Science Data***
Expanding beyond government observation networks, participants saw potential in leveraging citizen science data to enhance forecasting accuracy. One participant noted the opportunity to "train AI" using data from sources like "the citizen science observation network." The ECCC has a "CoCoRaHS " citizen science rain gauge network, where people can contribute data from their personal rain gauges. However, this data is not currently integrated directly into the ECCC's forecasting and warning systems. Crowdsourced weather observations could supplement official data, improving real-time modeling and forecasting capabilities.

• ***Feedback and Iterative Improvement***
A key concern was the lack of public feedback mechanisms. ECCC currently has limited feedback mechanisms, via the ECCC WeatherCAN app ratings and a national inquiry response, but said having a more iterative feedback process integrated into the system design would be very valuable. Participants emphasized the need for "a built-in feedback mechanism" that allows the public to provide real-time input. This reflects a desire for adaptive weather systems that evolve based on user feedback, rather than relying solely on one-way communication.

• ***Tailored and Impact-Based Messaging***
Participants also stressed the importance of AI-generated weather alerts that are not just generic forecasts but are specifically "angled towards preparation, messaging, and health and safety protection. " This suggests a need for impact-based messaging that prioritizes actionable preparedness over standard weather updates.

2.2.2 Geolocation and Targeted Alerts
• More granular, geolocation-based alerts rather than broad regional forecasts.
• Personalization remains a significant gap:

"A user should be able to input their profile—what their vulnerabilities are—and receive tailored alerts."

3: Opportunities for the Greatest Impact

3.1 Community-Centric Approaches

To improve heat risk communication, forecasting agencies must engage with local communities more effectively. Many most at-risk populations—such as those with mental health conditions, the elderly, people who are homeless/unhoused, outdoor workers, and low-income communities—lack the resources or awareness to respond effectively to extreme heat. Reaching and protecting these most at-risk groups is seen as a major challenge. Tailoring messages to specific demographics and strengthening partnerships with community organizations could improve response rates.

Additionally, fostering citizen participation through social media engagement, surveys, and public feedback loops could enhance public trust in official forecasts.

- Engagement beyond surveys: Incorporate citizen science and social media feedback loops to refine forecasting.
- Tailored messaging: most at-risk groups (e.g., elderly, people who are homeless/unhoused) require customized alerts.
- Stronger cross-agency coordination: Ensuring public health and emergency management align with forecasting priorities.

3.1.1 Targeted Outreach to At-Risk Groups

Expand community-based notification systems, including SMS alerts, social media updates, and partnerships with local organizations for on-the-ground support.

"Whole of Society" Approach

Encourage more affluent and able-bodied community members to check on and support most at-risk individuals during extreme heat events.

Formalized Outreach

Develop more formalized programs and door-to-door outreach to effectively identify and assist most at-risk populations.

Tailored Communication

Ensure warning messages are accessible and actionable for diverse audiences, including most at-risk groups.

Social Services Involvement

Involve social services ministries and community organizations, but recognize their resource limitations.

Discussion points to the need for multi-pronged, community-centric strategies that specifically target and support the most at-risk members of the population during extreme climate events. Challenges exist in getting all regions and jurisdictions to prioritize addressing heat impacts on most at-risk populations, especially in areas where heat may not be seen as a major risk compared to other hazards.

3.2 Smart Technology & Mobile Integration

Mobile technology presents a significant opportunity for improving heatwave forecasting. Several participants suggested that integrating heat warnings into widely-used health and wellness apps could increase public uptake.

For example, individuals with asthma could receive alerts specifically tailored to their condition, warning them of high heat and air quality concerns. Similarly, public health agencies could leverage mobile notifications to reach most at-risk groups in real-time.

• **Mobile notifications & health app integrations** could enhance uptake:

"If we integrated heat alerts into Samsung Health or Telus Health, it could provide better, personalized warnings."

• **AI-driven or ML forecasting models:** Freeing forecasters to focus on interpretation and impact messaging.

3.3 Cross-Agency Coordination and Collaboration

Structural challenges—including resource limitations, policy fragmentation, and inconsistent data-sharing between agencies—were identified as key barriers to improving heatwave forecasting. A more centralized, collaborative approach is needed to ensure that public health, emergency management, and meteorological agencies are aligned in their response strategies.

Additionally, stakeholders emphasized the importance of securing sustainable funding for forecasting innovations. Many promising technologies—such as AI-driven forecasting, real-time impact tracking, and personalized alert systems—require ongoing investment to be effectively implemented.

Cross-Agency Coordination and Collaboration

- Improve data-sharing between public health, emergency management, and meteorological agencies.
- Develop a centralized decision support system to enhance coordination.

Challenges Identified

- **Infrastructure & resource limitations:** Unequal distribution across provinces.
- **Data quality & integration issues:** Lack of standardized real-time impact data.
- **Policy inconsistencies:** Heat risks are not prioritized equally across regions.
- **Technical limitations:** Current models do not allow for individualized, location-based warnings.

The findings highlight clear opportunities and entry points for innovation in BC's heatwave forecasting system. To improve forecasting effectiveness, key areas of focus should include:

- **Enhancing accessibility** through multilingual, multimodal, and personalized alerts.
- **Stronger public engagement:** Community-centric approaches leveraging behavioral insights, partnerships, and real-time feedback mechanisms.
- **Leveraging smart technology** such as AI-driven forecasting, geolocation-based alerts, and health app integration.
- **Strengthening cross-agency coordination** to ensure a unified, proactive, and data-driven approach to improve preparedness.

These insights provide a foundational roadmap for research, policy decisions, and technological innovations, ensuring BC's heatwave forecasting system evolves to meet user needs effectively. British Columbia can build a more adaptive, user-centered, and resilient heatwave forecasting system that better serves both technical decision-makers and the public.

4: User Experience (UX) Vision for an Enhanced Heat Wave Forecasting System in British Columbia

As part of the needs assessment, participants were asked to engage in a visioning exercise, imagining an ideal user experience (UX) for an improved heatwave forecasting system in British Columbia (BC). This exercise sought to capture how forecasting and alert systems could be more intuitive, personalized, accessible, and engaging for diverse users. By reflecting on their wishes, frustrations, and desired features, participants described a future system that would not only deliver accurate forecasts but also empower users to act on heat warnings in a way that feels seamless and relevant to their needs.

The key themes that emerged from this exercise align with core UX principles, including personalization, accessibility, proactive engagement, and real-time adaptability. This section presents their UX vision, integrating direct quotations to preserve their perspectives.

4.1 A Personalized and Adaptive Forecasting Experience

A recurring theme was the need for personalization—a forecasting system that adapts to individual user needs rather than providing one-size-fits-all warnings. Participants envisioned an interface where users could input their personal risk factors (e.g., age, medical conditions, housing situation) and receive tailored warnings based on their vulnerabilities.

"It would be really cool if there was some sort of interface where a user could put in their profile that highlights what their vulnerabilities are, their sensitivities, and then it would take the warnings or alerts and give them personalized information about how to act on them."

Participants imagined a system where the forecasting service remembers user preferences, adjusting the type and frequency of alerts based on past interactions.

"Right now, heat warnings feel so generic. I don't want to receive an alert that just says 'heat warning issued.' I want it to tell me what it means for me specifically-whether I need to take extra precautions because of my asthma or if it's safe for me to go for a run."

They also emphasized the importance of localization, ensuring that alerts reflect hyper-local conditions rather than broad regional forecasts.

"I should be able to set my own temperature threshold for alerts. The heat in Vancouver is very different from the heat in Kamloops, but right now, we're all getting the same warnings."

4.2 Seamless Integration into Everyday Digital Ecosystems

Participants wanted heat warnings to be delivered through platforms they already use - eliminating the need for extra effort in seeking out information.

"Why can't heat alerts just show up in my weather app the same way storm warnings do?"

"If you put in that you have asthma or a health condition and all the factors that could impact that, we could integrate heat alerts into those health applications to say, 'This isn't a good time to go running."

The vision was for a connected system that integrates with existing health, wellness, and smart home applications. For example:

- Smartwatches and fitness apps could provide real-time alerts that adjust workout recommendations based on heat risk.
- Social media platforms could push localized community-based alerts, ensuring that most at-risk populations are reached.

"Leveraging some of those applications to get that information out... We have the forecasts, we have the technology, but let's get it into people's homes and workplaces where they'll actually see it."

Participants also expressed interest in wearable integration, where devices could provide real-time feedback based on biometric signals, such as dehydration levels or heart rate spikes during extreme heat.

"Imagine if my smartwatch could warn me, 'Your body temperature is rising too quickly—take a break and drink water.' That would be useful."

4.3 Intuitive and Engaging UX with Proactive Guidance

Participants wanted a system that not only provides information but also guides users on what actions to take. Instead of just issuing a heat warning, the system should:

- Explain why the warning matters
- Offer clear, actionable steps
- Provide real-time updates based on changing conditions

"It's not just about getting an alert. It's about knowing what to do with that information in the moment."

Several participants highlighted the power of behavioral insights in encouraging protective actions. For example, gamification elements—such as earning points for setting up a personalized heat plan or receiving positive reinforcement for taking safety precautions—could improve user engagement.

"If we could turn preparedness into a game, where people get reminders and incentives for following heat safety advice, we might see better uptake."

There was also discussion about using engaging storytelling techniques to make warnings feel more relatable. Instead of generic messages, participants wanted alerts that connect with real-life experiences.

"What if instead of saying, 'Heat warning issued,' we said, 'Think about your elderly neighbor today—check in on them'? That's something people will actually act on."

This speaks to the power of narrative framing and social norms to encourage prosocial behavior during extreme heat.

4.5 A System That Learns and Evolves Based on User Feedback

A major UX gap identified was the lack of feedback mechanisms. Participants wanted a forecasting system that is continuously improving by incorporating real-time public input.

"I should be able to tell the system when an alert was helpful or when it wasn't. That way, the messaging can evolve over time."

Many envisioned an interactive feedback loop, where users could report on the effectiveness of warnings:

- Did they receive the alert in time?
- Was it clear and actionable?
- Did they take any protective measures as a result?

"Right now, warnings are just sent out and that's it. There's no way to know if they actually worked."

Some participants also suggested that feedback data should be publicly visible so people can see how others in their community are responding to warnings.

"If I could see that my neighbors are taking precautions, I'd be more likely to take them too."

4.6 A Vision for an Intelligent Heat Forecasting System

Bringing all these ideas together, participants described an ideal UX for a future heatwave forecasting system that is:

Personalized – Alerts tailored to individual risk factors and behaviors.
Integrated – Embedded into apps and devices people already use.
Engaging – Uses behavioral insights, gamification, and real-world storytelling to drive action.
Actionable – Provides guidance beyond warnings, offering clear next steps.
Evolving – Learns from user feedback and adapts over time.

This vision aligns closely with UX design principles—emphasizing usability, accessibility, and proactive engagement. By implementing these elements, BC's heatwave forecasting system can move from simply providing information to enabling action, ensuring that heat warnings translate into real-world preparedness and protection.

4.7 Food for Thought: Designing an Inclusive Heatwave Forecasting System

The public want more than just static heatwave warnings—they need something personalized, intuitive, and seamlessly integrated into their daily lives. In the visioning exercise, participants described their ideal experience as something much more dynamic. Beyond just warnings, they want actionable, relevant, and engaging information that helps them respond effectively.

But turning this vision into reality brings up three key UX challenges: Accessibility, Prototyping, and Inclusive Design. These will determine how well the system truly serves everyone, regardless of their needs or circumstances.

4.7.1 Expanding Accessibility Considerations

Not everyone has a smartphone, reliable internet, or the know-how to navigate apps—so how do we make sure they're not left out? While mobile apps, smart home integration, and wearable devices offer exciting possibilities, many people still rely on more traditional forms of communication.

Some key questions to think about:

- How do we reach users who don't use apps or wearable technology?
- Should heat alerts be integrated into radio, TV, and community networks for broader access?
- Can voice assistants, text messages, or even neighborhood alert systems help close the gap?

For example, in the Maritimes, TV and radio were the primary sources for heat warnings. In fact, ECCC ranked much lower—only 8% of people relied on it for their weather updates. This tells us something important: people act on information that comes from sources they trust.

This is an opportunity to explore community-driven models for getting warnings out to those who need them most, in formats they can easily understand. If the goal is inclusive engagement, the system has to meet people where they are—not just where we expect them to be.

It also suggests that investing in messenger trust—by partnering with familiar media channels or community figures—could enhance credibility and uptake.

4.7.2 Prototyping & Usability testing

A great UX vision is only as strong as its execution. To make sure the system works the way people actually need it to, prototyping and testing are crucial.

Some key questions:

- What would a minimum viable product (MVP) look like?
- Which features should be tested first—personalized alerts, location-based notifications, or interactive feedback loops?
- How do we measure whether new approaches actually improve how people respond to warnings?

Right now, many heatwave warnings fail to prompt action—either because they feel irrelevant, arrive too late, or don't clearly tell people what to do next. Testing different messaging styles, notification formats, and delivery methods will be key to figuring out what really drives behavior change.

"It's not just about getting an alert. It's about knowing what to do with that information in the moment."

A successful UX approach isn't just about designing something once—it's about constantly testing, improving, and adapting based on real-world feedback.

4.7.3 Emphasizing Inclusive Design

Making a system accessible is just the start—true inclusive design means ensuring every user can engage with it in a meaningful way. That includes most at-risk populations like the elderly, people who are homeless/unhoused, outdoor workers, people with disabilities, and those living in heat-affected urban areas.

Some key questions:

- How can we ensure the system works for those most at risk?
- Can heat alerts prioritize people without air conditioning or those who work outdoors?
- How do we make sure information is available in multiple languages and for people with different literacy levels?
- How can we integrate usability testing early in the design process to ensure public involvement in the development of heat warning systems. This helps refine message clarity, accessibility, and trustworthiness from the outset.

Some participants imagined an interface that adapts based on individual vulnerabilities, while others highlighted the need for real-time community data to better reflect risks for different groups.

"We really do depend on that real-time—or as close to real-time—data about what the impacts are."

By incorporating universal design principles, the system can work for everyone—regardless of ability, background, or socioeconomic status.

Enhancing heatwave forecasting and public uptake isn't just about technology—it's about people. We need a human-centered UX approach that does more than just deliver information; it empowers people to take timely, meaningful action in ways that fit into their everyday lives.

By prioritizing accessibility, usability testing, and inclusive design from the start, we can create a solution that bridges the gap between forecasting and public action—ensuring people get the right information at the right time and are equipped to act when it matters most.

Part 2:

Research-Driven Solutions – Global Innovations in AI Forecasting

5. AI in Weather Forecasting: Bridging Needs and Innovation

The insights gathered from stakeholders in British Columbia underscore the importance of improving personalization, increasing public trust, enhancing clarity in messaging, and leveraging emerging technologies in heatwave forecasting. To inform the next phase of solution design, we turned to global research on the role of artificial intelligence (AI) and machine learning (ML) in weather prediction and public engagement.

This section synthesizes findings from a targeted literature review, focusing on how AI has been deployed in forecasting systems around the world, the challenges of public trust, and strategies to mitigate alert fatigue. By exploring these trends, we aim to highlight practical design considerations that can support more accurate, trusted, and accessible heat warnings in the BC context.

Our exploration focused on three main areas:

- AI in Weather Forecasting – examining its trustworthiness, accuracy, and public response.
- Key Considerations – assessing the feasibility of AI adoption in British Columbia (BC) and Canada, along with public trust and perception of AI-generated forecasts.
- Lessons from Successful AI Implementation – identifying best practices, feasibility challenges, and potential risks.

By incorporating these insights into the design of interventions and models, BC's heatwave forecasting system can build on proven strategies, avoid common pitfalls, and strengthen public trust and engagement.

5.1 Trust, Accuracy, and Public Response

Key Insight 1: Public Tolerance for False Alarms Differs Between Traditional and AI Forecasts

Traditional Forecasting Challenges

- False alarm rates for tornado warnings can be as high as 75%, contributing to public desensitization and reduced trust in alerts[1] (Snodgrass, 2023).
- Heatwave forecasting systems often have an overforecast bias, leading to warning fatigue and lower public responsiveness[2] (McLean et al., 2018).

AI Forecasting Challenges

- Public expectations for AI accuracy are significantly higher, meaning that even minor errors can lead to disproportionate mistrust[3] (Yang et al., 2024).
- Emerging AI-generated weather systems, such as Google DeepMind's GenCast, aim to reduce false alarms and improve forecast precision.

Considerations for Implementation in BC:

- AI-enhanced forecasting can improve accuracy and efficiency, but managing public expectations is crucial.
- Transparent communication about AI reliability and limitations is essential to prevent trust erosion.

Snodgrass, K. R. (2023). Tornado outbreak false alarm probabilistic forecasts with machine learning. Mississippi State University Mississippi State University.

McLean, K. E., Stranberg, R., MacDonald, M., Richardson, G. R. A., Kosatsky, T., & Henderson, S. B. (2018). Establishing Heat Alert Thresholds for the Varied Climatic Regions of British Columbia, Canada. International Journal of Environmental Research and Public Health, 15(9), 2048. https://doi.org/10.3390/ijerph15092048

Yang, R., Hu, J., Li, Z., Mu, J., Yu, T., Xia, J., Li, X., Dasgupta, A., & Xiong, H. (2024). Interpretable Machine Learning for Weather and Climate Prediction: A Survey (arXiv:2403.18864). arXiv. https://doi.org/10.48550/arXiv.2403.18864

Key Insight 2: Evaluating the Credibility of AI-Generated Weather Information

Meteorologists' Perspective

- Physics-based models form the foundation of traditional forecast credibility.
- Trust in new AI tools is built through iterative evaluation of model techniques, data quality, and verification metrics (Yang et al., 2024).
- Initial transparency in AI model development is essential for fostering long-term trust.

Public Perception of AI Forecasting

- The "algorithmic aversion" effect—people distrust AI more than human forecasters when errors occur, even if AI is more accurate overall[4] (Wigglesworth, 2024).
- Simpler AI models generate higher public trust than complex deep learning systems, reinforcing the importance of explainability (Wigglesworth, 2024).

Considerations for Implementation in BC:

- Integrate usability testing early in the design process to ensure public involvement in the development of heat warning systems. This helps refine message clarity, accessibility, and trustworthiness from the outset.
- User education campaigns should clarify how AI-generated forecasts work to increase trust.
- Simplifying AI-driven messaging and offering explainable forecasts can boost public acceptance.

5.2 Public Trust & Response to AI-Generated Heat Warnings

Key Insight 3: Factors Influencing Public Action in Response to Heat Warnings

Message Clarity & Customization

- Clear, consistent, and context-sensitive messaging reduces warning fatigue and increases public responsiveness (McLean et al., 2018).
- Heat warnings should be tailored to different regions, as vulnerability levels vary (McLean et al., 2018).
- Trust builds over time through consistent, transparent messaging[5] (World Health Organization, 2021)

5 World Health Organization. (2021). Heat and health in the WHO European Region: Updated evidence for effective prevention.

4 Wigglesworth, R. (2024, September 17). Algorithmic analyst aversion. Financial Times. https://www.ft.com/content/2a0f07fa-20a7-4bd1-b34e-c19bcb20eded

Source Authority & Institutional Reputation

- Gradual trust-building through iterative use and feedback is crucial[6] (Cains et al., 2024).
- The format of information delivery matters: notifications that appear authoritative (like TikTok's news-style alerts) can create unwarranted trust in false information, while simultaneously eroding overall credibility in digital information sources when inaccuracies are discovered[7] (Stacey, 2024).

Sociodemographic Factors

- Demographic factors such as AI literacy, gender, and political affiliation influence public trust in AI forecasts, with women, Democrats, and those with higher AI literacy more receptive to AI-driven weather predictions (Wigglesworth, 2024).
- Personal experiences with extreme weather events and local vulnerabilities shape how people interpret and respond to heat warnings.

Considerations for Implementation in BC:

- Integrate usability testing early in the design process to ensure public involvement in the development of heat warning systems. This helps refine message clarity, accessibility, and trustworthiness from the outset.
- Customize warnings for different regions and populations, considering demographics and prior experiences with extreme heat.
- Address misinformation risks by partnering with trusted media sources to amplify correct information.

5.3 Addressing Public Response Fatigue & False Alarms

Key Insight 4: How False Alarms Shape Future Public Response

Adaptive Trust & Preparedness

- Repeated false alarms don't always reduce trust—they may actually paradoxically increase preparedness as people recalibrate risk assessments (Snodgrass, 2023).

6 Cains, M. G., Wirz, C. D., Demuth, J. L., Bostrom, A., Gagne, D. J., McGovern, A., Sobash, R. A., & Madlambayan, D. (2024). Exploring NWS Forecasters' Assessment of AI Guidance Trustworthiness. Weather and Forecasting, 39(8), 1219–1241. https://doi.org/10.1175/WAF-D-23-0180.1

7 Stacey, S. (2024, August 12). Misleading TikTok alerts include false Taylor Swift claims and old tsunami warning. Financial Times. https://www.ft.com/content/8f0a08c9-1ba6-4df5-a6bd-ac7d288e5ca2

Mitigating Warning Fatigue

- Heatwave warning systems require bias adjustment to prevent desensitization from excessive false alarms (McLean et al., 2018)

Iterative Improvement

- Ongoing feedback loops allow both forecasters and the public to adjust trust levels, preventing early inaccuracies from causing permanent confidence erosion (Cains et al., 2024).

Considerations for Implementation in BC:

- Use historical data to refine warning thresholds and prevent excessive false alarms.
- Implement user feedback loops to continuously improve forecast accuracy and credibility.

5.4 Implications for Enhancing Heatwave Forecasting System and Public Uptake

Best Practices from the Literature Review:

AI-Generated Forecasting Can Improve Accuracy

- Machine learning tools like Google DeepMind's GenCast have shown promise in reducing false alarms.
- Transparent AI communication is key to building trust with both the public and meteorologists.

Personalization & Regional Thresholds Matter

- Heat warnings should be customized for different geographic regions to improve public responsiveness.
- Tailored risk messaging enhances personal actionability.

Mitigating Warning Fatigue is Crucial

- AI-generated forecasts should be monitored for over-alerting risks.
- Iterative public feedback loops help maintain long-term credibility.

Trust in AI Requires User Engagement & Education

- Public acceptance of AI-generated forecasts depends on education, transparency, and explainability.
- Simplifying complex AI forecasts can increase user confidence and adoption.

Part 3:

Translating Forecasts Into Action – Global Case Studies for Public Uptake

From Innovation to Implementation

While emerging technologies such as AI offer promising advancements in heatwave forecasting, their impact ultimately depends on whether people understand, trust, and act on the warnings they receive. This section shifts the focus from technological innovation to practical, community-facing interventions that have successfully improved public uptake in a range of global contexts.

Drawing on international case studies, we explore how public agencies and their partners have enhanced accessibility, strengthened multi-agency coordination, incorporated real-time public feedback, and increased resilience among vulnerable populations. These examples provide actionable insights that can inform how British Columbia adapts and scales proven strategies—from color-coded alerts to finance-integrated early warning systems—to bridge the gap between forecast issuance and protective public action.

Each case study highlights the challenge, innovation, approach, and impact, offering concrete strategies for improving BC's heatwave forecasting and response systems. Together, they illustrate best practices, feasibility considerations, and entry points for adaptation within the province's unique institutional and climate context.

The case studies are grouped into five key focus areas:

- Improving Public Accessibility & Engagement (e.g., website enhancements, media integration)
- Strengthening Public Uptake of Weather Warnings (e.g., color-coded alerts, reinforcement strategies)
- Real-Time Adaptation & Citizen Science (e.g., crowdsourced data, hyperlocal sensors)
- Health-Based Early Warning Systems
- Finance-Linked Early Warning Systems

To ground these insights, the following matrix summarizes the global strategies that informed the case studies. It offers a high-level comparison of innovation types, features, and relevance to British Columbia.

Global Innovations Comparison Matrix

Country / Program	Innovation Type	Key Features	Relevance to BC
UK Met Office (WOW)	Citizen Science & Public Engagement	Crowdsourced data via WOW; public engagement tools	Enhance public trust and localized feedback
Greece – Heat Health EWS	Health-Integrated Early Warning System	Combines weather data with health indicators; triggers early action	Model for syndromic surveillance integration
Atlantic Council – Climate Resilience Center	Finance-Integrated Early Warning & Resilience	Heat alerts linked to insurance, safety funds, and mobile alerts	Template for linking forecasts to social support tools
Ireland – Met Éireann	Color-Coded Warning System	Three-tier (Yellow, Orange, Red) system with clear thresholds	Improves clarity and urgency of public warnings
Germany – DWD	Unified Multi-Agency Messaging	Single voice principle across agencies	Ensures message consistency across public platforms
New Zealand – MetService	Website Usability & Multimedia Forecasting	Looping video charts, interactive design, forecaster videos	Low-barrier upgrades to improve user experience
Brazil – INMET	Website Navigation Enhancements	Tabbed navigation, real-time data access	Simplifies public access to critical warnings
UBC/Glacier Media – Weatherhood	Hyperlocal Temperature Sensor Network	Over 60 hyperlocal sensors across urban areas	Improves micro-climate forecasting in urban zones
South Korea – IoT Wearables	Wearable Heat Stress Monitoring	Real-time biometric alerts for outdoor workers	Protects vulnerable outdoor labor force

6. Case Study: Improved Public Accessibility & Engagement

The Challenge

- Public uptake of weather warnings remains low because ECCC is not a primary source of information—many people rely on TV, social media, and alternative weather networks.
- Taking action requires awareness, yet ECCC sources are often “way down the list” in terms of how the public receives weather information.

Innovations from Global Models

MetService NZ – Uses looping video charts to create dynamic, engaging content.
INMET Brazil – Enhances usability through simplified tab navigation for switching between warnings and forecasts.
UK Met Office – Established a dedicated forecaster media team that bundles data and services for easy media access. These forecasters appear in short explainer videos for the website.

Proposed Approach for BC

- **Make the Website More Engaging** – Small but impactful enhancements to website’s layout, color coding, and interactive features to make it more user-friendly. Even simple changes—like a more intuitive landing page and multimedia enhancements—can make the site more accessible and engaging.

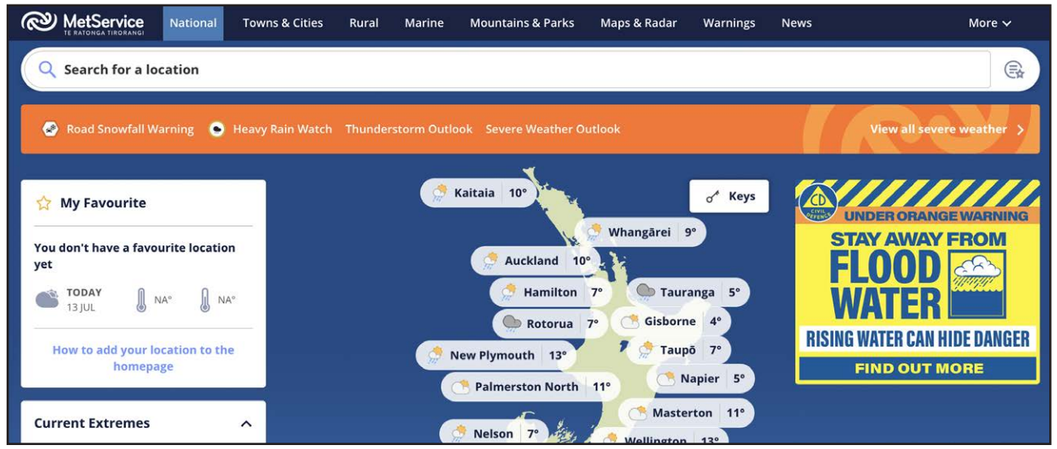
- **Simplify Media Access** – Create a dedicated media hub where journalists can quickly find real-time weather updates, forecasts, and emergency information. A streamlined system for media inquiries will help ensure accurate and timely coverage, especially during severe weather events.

- **Strengthen Trust Through Consistency** – Building strong relationships and delivering a reliable, high-quality service can increase public trust and ensure critical weather updates reach more people when it matters most.

- **Expand Public Communication with Video** – Create short, engaging videos—either with visuals and text or a presenter—to explain key weather updates and emergency alerts. These can be shared on social media and featured on the website to improve accessibility and reach a broader audience.

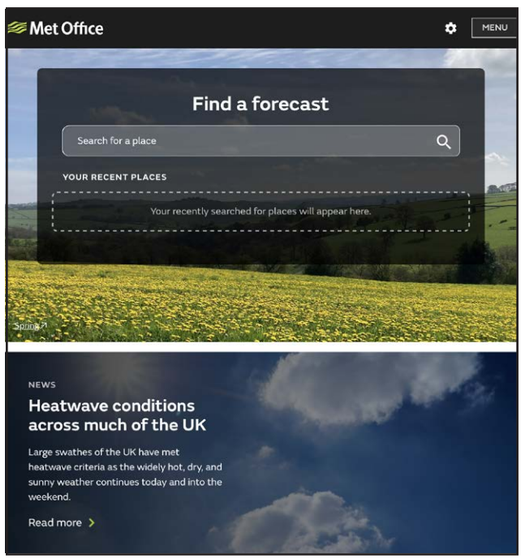
Expected Impact

• **Increased trust & visibility** – A well-structured, engaging website can enhance public confidence in heat warnings.
• **More accessible & action-driven forecasts** – Developing short explainer videos for social media and ECCC's website can expand reach, while improved navigation helps reduce cognitive barriers to understanding warnings.



MetService NZ

INMET Brazil



UK Met Office

7. Case Study: Strengthening Public Uptake of Weather Warnings

The Challenge

• **"Getting the public to understand and act on weather warnings"** and to ensure that there is an **"awareness and understanding of a marginal heat event versus a more extreme one."**

• Warnings from ECCC often **lack reinforcement from other agencies,** weakening **perceived urgency.**

Innovations from Global Models

Met Éireann (Ireland) – Uses a three-tier color-coded system (Yellow, Orange, Red) with a 60-hour lead time aligned with European MeteoAlarm standards.
DWD (Germany) – Promotes a "single voice principle" to reinforce the authority of official weather warnings.

Yellow	Not unusual weather. Localised danger.
Orange	Infrequent. Dangerous.disruptive.
Red	Rare. Extremely dangerous/destructive.

Proposed Approach for BC

• **Color-Coded Warning System** – ECCC is considering implementing a tiered color system to differentiate heat event severity levels.

• **Reinforcement Across Agencies** – Ensure government health websites and emergency preparedness pages directly reference ECCC warnings.

• **Consistency in Messaging** – Work with public and private sector partners to ensure clear, unified communication.

Expected Impact

• **Improved public understanding** – Clear, color-coded warnings enhance understanding, making risk perception more intuitive and increasing the likelihood of appropriate action, ultimately improving emergency preparedness.

• **Higher engagement & credibility** – Reinforced messaging ensures that ECCC remains the authoritative voice on weather warnings.

8. Case Study: Real-Time Adaptation & Citizen Science

The Challenge

• Need for real-time or near real-time public-generated data—integrating citizen science weather observation data (e.g. personal rain gauges)—to complement existing observational data already routinely produced and used at ECCC.

• ECCC has a volunteer network for precipitation and encouragement to 'report signs of severe weather' via a X hashtag or email address, but these are underutilized.

Innovations from Global Models

UK Met Office WOW (Weather Observation Website) – A global citizen science network that integrates crowdsourced weather data.

Weatherhood (UBC and Glacier Media Canada) – Uses 60+ hyper-local sensors across Vancouver to provide granular temperature readings.

IoT & Wearable Sensors (Seoul, South Korea) – Deploys real-time heat stress monitoring for outdoor workers.

Proposed Approach for BC

• **Leverage Citizen Science Networks** – Promote existing ECCC platforms for weather data collection can expand public participation and engagement, being a bottom-up approach to weather or heat awareness.

• **Deploy Sensor-Based Data Collection** – Expand IoT networks for localized real-time temperature tracking.

• **Encourage Public Participation** – Engage citizens via social media campaigns and user-friendly reporting apps.

Expected Impact

• **Better localized data for forecasting** – Crowdsourced observations add granularity to ECCC's existing forecast models.

• **Increased public engagement** – Citizen science encourages bottom-up participation in climate risk awareness.

Implications for Bridging the Gap Between Forecasting & Public Action

Best Practices from Global Innovations:

Enhance digital accessibility Website Usability & Public Messaging

• Simplify the user interface and create interactive content (MetService NZ, INMET Brazil).

• Invest in messenger trust—by establishing a media-savvy forecasting team for better public outreach or partnering with familiar media channels or community figures—could enhance credibility and uptake (UK Met Office).

Strengthen Warning Systems Through Clarity & Reinforcement

• Implement color-coded alerts with clear, recognizable severity levels (Met Éireann).

• Promote a single authoritative voice by integrating weather warnings across agencies (DWD Germany).

Expand Real-Time Data Collection with Citizen Science

• Utilize public sensor networks & real-time user feedback loops (Weatherhood, UK Met Office WOW).

• Promote hyperlocal data collection for improved regional heat risk tracking.

9. Case Study: Climate Resilience Center's Finance-Integrated Early Warning System

Adaptation Planning, and protecting At-risk populations

The Challenge

• Traditional Early Warning Systems (EWS) alert communities to extreme heat events but often lack mechanisms to support low-income populations in taking protective action[8].

• A unified approach that combines heat early warning systems with climate finance tools[9] can enhance resilience by ensuring people not only receive warnings but also have the financial means to respond effectively[10].

Global Innovations

The Atlantic Council's Climate Resilience Center, is dedicated to creating and implementing transformative solutions that enhance resilience against climate impacts. Their mission is to improve lives, protect livelihoods, and expand opportunities for communities most affected by climate change.

The Climate Resilience Center is pioneering an integrated approach that links early warning systems (EWS) with climate finance mechanisms. In pilot programs across heat-prone regions, alerts have been integrated with micro-insurance schemes.

Climate-Linked Financial Tools

• Parametric Insurance[11]: Provides rapid payouts when predefined extreme heat conditions are met, offering financial support without the need for lengthy claims process.

• Heat Safety Funds: Allocated resources to assist with expenses related to purchasing cooling devices, paying for temporary relocation, or staying home from work without income loss.

8 Accelerating the Deployment of Climate Financing for Early Warning Systems

9 Inventory of Innovative Financial Instruments for Climate Change Adaptation

10 Heat Health Early Warning Systems - Arsht-Rock

11 Fighting extreme heat with parametric insurance

Real-Time Heat Alerts

• Utilizes mobile and digital platforms to deliver timely heat alerts, accompanied by clear explanations of associated risks and recommended actions.

Relevance of Approach for BC

Implement Integrated EWS

• Combine real-time heat alerts with financial support mechanisms to empower vulnerable communities to take necessary precautions during extreme heat events.

Develop Financial Support Programs

• Introduce parametric insurance schemes and establish heat safety funds to provide immediate financial assistance for preventive measures, such as purchasing cooling devices or covering lost income due to heat-related work absences.

Expected Impact

Increased Resilience

• Empowers low-income communities to proactively respond to heat warnings, reducing health risks and economic losses.

Enhanced Public Safety

• Ensures timely dissemination of heat alerts, enabling individuals to take appropriate actions to protect themselves and their families.

This integrated approach bridges the gap between awareness and action, empowering at-risk communities to safeguard both their health and economic stability in the face of increasing extreme heat events.

10. Case Study: Greece's Heat Health Early Warning System

Targeted Emergency Responses

The Challenge

Greece faces severe heat waves, posing significant health risks to its population. Traditional warning systems primarily relied on temperature forecasts without integrating health impact data.

Global Innovations

Heat Health Early Warning System

• *Integration of Weather Forecasts with Health Data*[12]*:* The Hellenic Red Cross, in collaboration with the Climate Resilience Center, implemented a health-based heat early warning system. This system combines weather forecasts with historical health and meteorological data to predict health impacts more accurately. In June 2024, during a severe heatwave, the system was activated, leading to proactive measures such as establishing water distribution points and conducting wellness checks, benefiting approximately 2,000 individuals.

Simplified Early Action Protocol (EAP)

• **Proactive Measure:** Upon forecasts predicting extreme heat (e.g., "Danger Level 4"), the Hellenic Red Cross activates the EAP to implement anticipatory actions.

Relevance of Approach for BC

Develop Integrated Early Warning Systems

• Collaborate with Meteorological and Health Agencies: Establish partnerships to merge weather forecasts with health data, enabling precise predictions of heat-related health risks.

12 Heat health early warning systems

Implement Early Action Protocols

• Define Activation Triggers: Set specific thresholds (e.g., forecasted temperatures) that prompt immediate protective measures.

• Community Outreach: Distribute resources such as water, sun protection, and health information to vulnerable groups before and during heat events.

Expected Impact

Reduced Heat-Related Health Issues

• Timely interventions can decrease the incidence of heat-induced illnesses and fatalities.

Enhanced Community Preparedness

• Educating the public fosters proactive behaviors during extreme heat conditions.

Strengthened Institutional Collaboration

• Coordinated efforts between meteorological, health, and emergency services ensure a unified response to heat waves.

11. Case Study: Climate Resilience through Gaming Technology

Long-Term Adaptation Strategies

The Challenge

• Rising climate impacts (e.g., extreme heat) threaten communities, with limited public awareness and adaptive skills.

• Need for scalable, engaging education on resilience solutions to reach billions by 2030.

Global Innovations

Heat Wave Survival:

• *The Atlantic Council's Climate Resilience Center*[13]. The Minecraft Education game teaches students globally to recognize and respond to extreme heat dangers.

Gaming Center of Excellence:

• Via partnerships with gaming industry veterans, developers the Climate Resilience Center integrating climate resilience into gameplay, aiming to reach 300 million players by 2030.

Relevance of Approach for BC

Educational Integration:

• Incorporate climate resilience games like Heat Wave Survival into BC's education system and community programs to enhance preparedness.

Local Game Development:

• Partner with local gaming studios to develop region-specific climate resilience games, leveraging local climate data and scenarios (e.g., wildfires, flooding) tailored to BC's climate risks.

13 Atlantic Council's Climate Resilience Center

Expected Impact

Enhanced Preparedness:

• Educated citizens equipped to respond effectively to climate hazards

Community Engagement:

• Empowered youth and communities with practical skills, reducing vulnerability and fostering long-term adaptation to climate challenges in BC.

Economic Growth:

• Stimulated local game development industry, fostering innovation and job creation in BC.

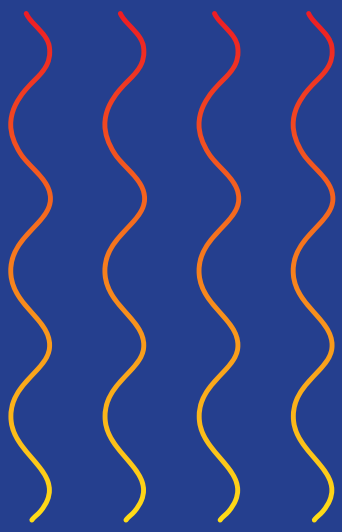
12. Conclusion

This report reflects a collaborative effort to understand and strengthen the uptake of heatwave warnings in British Columbia. Through a combination of stakeholder engagement, behavioral insights, global case studies, and emerging technology review, we have identified clear needs, promising innovations, and actionable opportunities for impact.

While heatwave forecasting in BC is technically robust, its ultimate value depends on whether individuals and communities understand, trust, and act on the warnings they receive. Stakeholders have expressed a strong appetite for innovation—particularly in building more personalized, trusted, and adaptive systems—but also emphasized the importance of sustained inter-agency coordination, behavioral framing, and public engagement.

Moving forward, this report can serve as both a reference and a springboard. It provides a foundation for developing new tools, research projects, partnerships, and investment strategies that align with the lived realities of users and the operational goals of forecasters.

We hope this document continues to serve as a living resource—a reference for new ideas, a benchmark for reflection, and a catalyst for cross-sector collaboration. As the impacts of extreme heat become more acute, the work of improving how warnings are communicated and acted upon has never been more urgent—or more possible.



Needs Assessment Report ECCC:
Enhancing British Columbia’s Heatwave Forecasting System